
Space Weather Technical Forecast

Issued on Wednesday, 20 September 2023 at 01:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of further G1-G2 minor/moderate storms Day 1 (20 Sep) as CME effects continue to wane. Isolated R1-R2 Minor/Moderate Radio Blackouts likely throughout. Electron Fluence likely above the Active threshold day 1 (20 Sep) onwards.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is Moderate over the past 24 hours, with the peak flares a M1.8 flare at 19/0938 UTC and a M4.0 flare observed around 19/2014UTC. Both flares associated with AR3435. There are currently eleven sunspot regions on the visible disc, with nine numbered. The largest and most active region on the disk is AR3435 in the east, with continuing magnetic complexity visible. This region has seen its previous leading spot re-numbered as AR3438, this region previously stable but has seen increasing magnetic development in recent hours, with signs of the local magnetic structure destabilise. AR3436 in the northwest also remains of interest, with continued slight growth and potential for brief delta spot potential with its central portion. The remaining regions are relatively unchanged with little activity, though a second as yet un-numbered bipolar region has developed quickly in the central-east disk in recent hours.

Both M-Class flare mentioned above look to have produced CMEs which are under assessment, with the first awaiting model output and the second available imagery.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by DSCOVR/ACE at L1, saw a slowly declining trend from a peak around 650km/s early in the period to current values around 550km/s. The solar wind density was at average to below average levels throughout. The IMF saw a decline early in the period from a peak around 15nT back towards weak to moderate levels around 5-8nT for much of the last 24hrs. The north-south component showed a similar trend, increasing from a minimum of around -14nT to start, to vary weakly between -6/+7nT for much of the period. The phi angle was highly variable for much of the period, but has become predominantly positive (Away from the Sun) in recent hours. Geomagnetic activity, as measured by BGS, was highly variable between Unsettled and G2 Moderate geomagnetic storm, and peaked at G3 Strong geomagnetic storm in the 19/0300-0600 UTC interval.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background Background levels. GOES16 high energy (greater than 2MeV) electron flux was at Normal Background to Moderate levels to start but rose quickly from around 19/1200 UTC to become Moderate to High. The associated 24-hour fluence was well below the Active threshold, but with a rising trend and 3.32×10^7 integrated pfu observed at 20/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be generally Moderate, with further isolated M-class flares likely, particularly from the AR3435/AR3438 area.

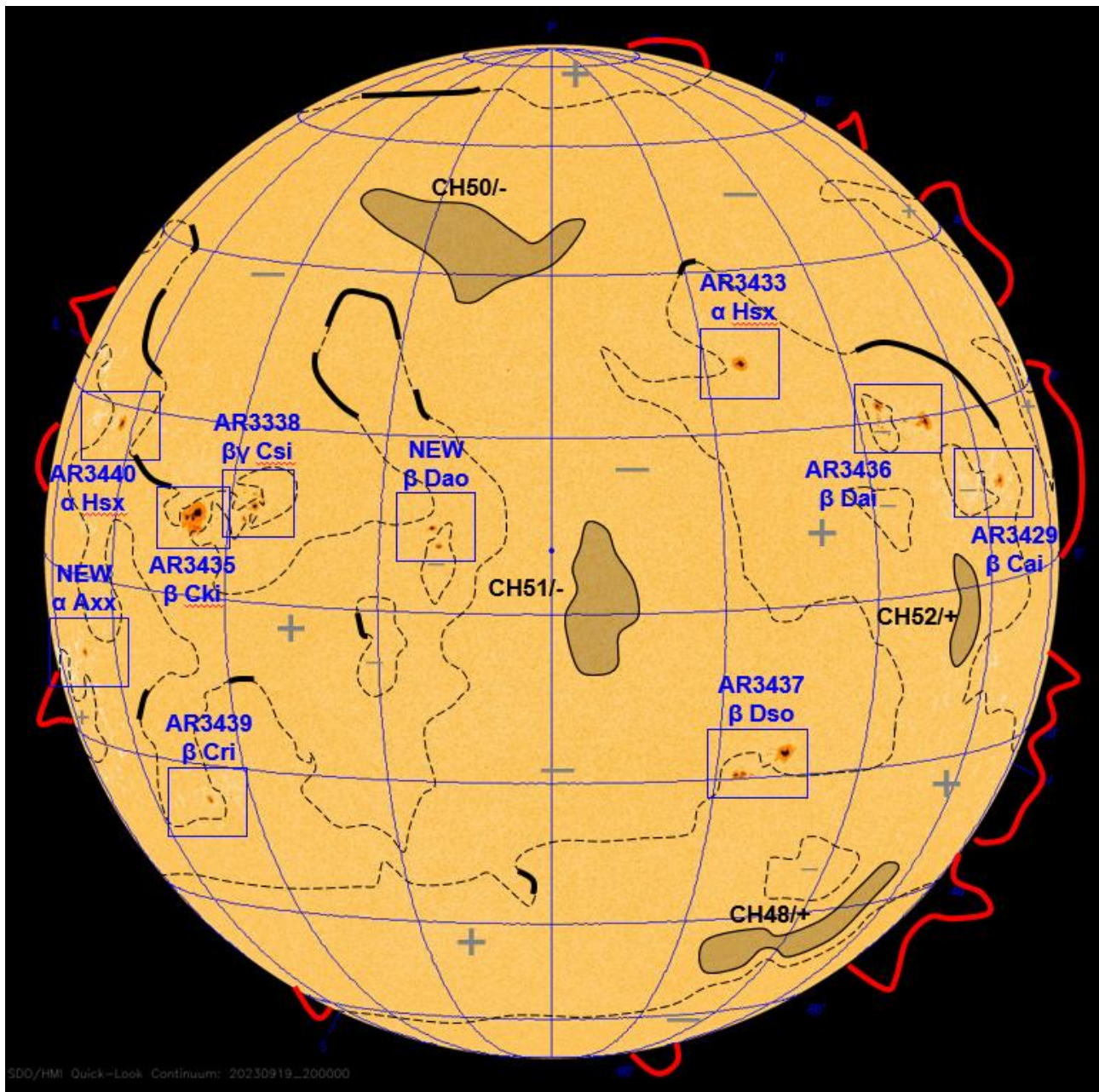
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

Solar Wind / Geomagnetic Activity: Current CME effects, increasingly though to be associated with the 16 Sep large filament lift off, look to be waning but are expected to continue through Day 1 (20 Sep), increasingly easing into Day 2 (21 Sep). Coronal hole influence likely late in the period. Generally Active geomagnetic activity expected at first, with a continued chance of further G1-G2 Minor to Moderate storms. CME effects likely easing into Day 2-3 (21-22 Sep) with generally Quiet to Unsettled conditions returning. Into late Day 3 and Day 4 (23 Sep) Unsettled to Active conditions becoming increasingly likely once again.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background levels, with a daily slight chance of an enhancement should any larger flares occur, or perhaps early in the period in association with CME arrival.

High energy (greater than 2 MeV) electron flux is currently close to High levels, and expected to generally High through much of the period, though with reduced confidence to start. Overall, the 24-hour fluence is now likely to rise above the Active threshold through Day 1 (20 Sep), and potentially remain elevated though with reducing confidence later in the period.

Figure 1. Solar Analysis Valid 19/2000 UTC.



Key: Filament --- , Prominence --- , Magnetic Field Line --- , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There are currently one ongoing CMEs that features in the forecast.

It is becoming increasingly likely as we move into the 20 Sep that the current CME influencing the near Earth environment is associated with the large filament lift off which occurred early on the UTC day of 16 Sep. This CME produced an asymmetric halo seen clearly in LASCO-C2 and C3 coronagraph imagery. Modelling suggested an Earth directed component with an arrival time sometime during 19 Sep. Analysis of this features was complex however, reducing forecast confidence and it now looks likely that we saw an earlier than expected arrival. CME effects look to be waning but are expected to continue through Day 1 (20 Sep), increasingly easing into Day 2 (21 Sep).

The background solar wind conditions have lower than average forecast confidence through the period, with conditions complicated by the potential influence from one or more coronal holes. The increasingly faded CH52/+ seeing any potential influence during Day 1 easing into the period. The centre disk CH51/- then increasingly likely to influence conditions later into Days 3-4 (22-23 Sep) though persistence data suggest that the current ENLIL signal for Elevated wind speeds looks slightly excessive.

CME effects are expected to continue easing into Day 1 (20 Sep). Generally Active geomagnetic activity at first, with a continued chance of further G1-G2 Minor to Moderate storms. CME effects likely easing into Day 2-3 (21-22 Sep) with generally Quiet to Unsettled conditions returning. Into late Day 3 and Day 4 (23 Sep) Unsettled to Active conditions becoming increasingly likely once again.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	Yes	40	10	5	10
Strong	G3	Yes	5	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
16/0800-1000	Full	Filament Eruption	Centre disk	635 km/s	19/1200 UTC	Now thought to have arrived early and be ongoing

Radio Blackouts - X-Ray Flares:

The largest and most active region on the disk is AR3435 (Cki/Beta) in the east, with the recent M4.0 flare an escalation of activity. Continuing magnetic complexity visible with a north-south magnetic alignment likely aiding shear instability. This region recently saw its previous leading spot re-numbered as AR3438 (Csi/Beta, this region was previously stable but has seen increasing growth and magnetic development in recent hours, with signs of the local magnetic structure destabilise and will need to be closely monitored. AR3436 in the northwest also remains of interest, with continued slight growth and potential for brief delta spot potential with its central portion. A second as yet un-numbered bipolar region has developed quickly in the central-east disk in recent hours. Overall the activity on the visible disk is increasing in both number of regions and magnetic complexity, with an increase in flare risk accepted. AR3436 will approach the limb by the end of the period, but with signs of further development likely on the disk during the period flare risk is maintained throughout.

Solar activity is expected to be generally Moderate, with further isolated M-class flares likely, particularly from the AR3435/AR3438 area.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 2: Latest 24hr GOES X-Ray Flux showing increased activity.

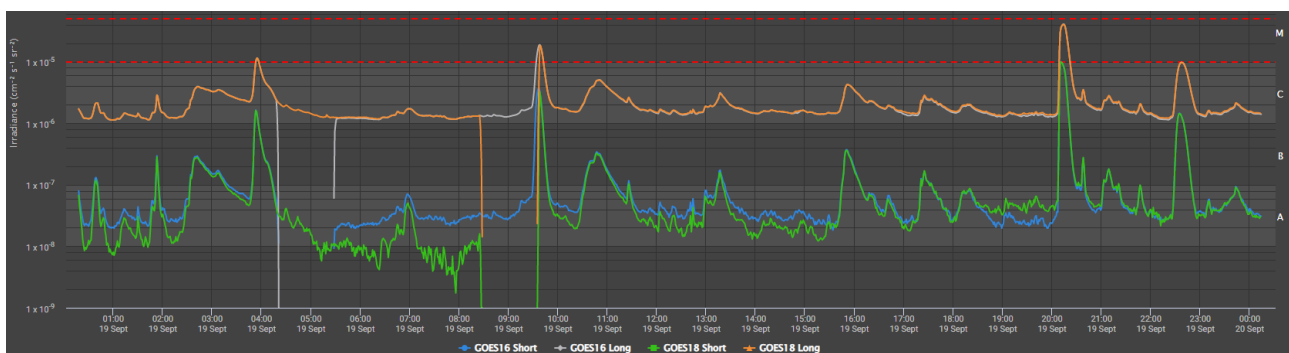
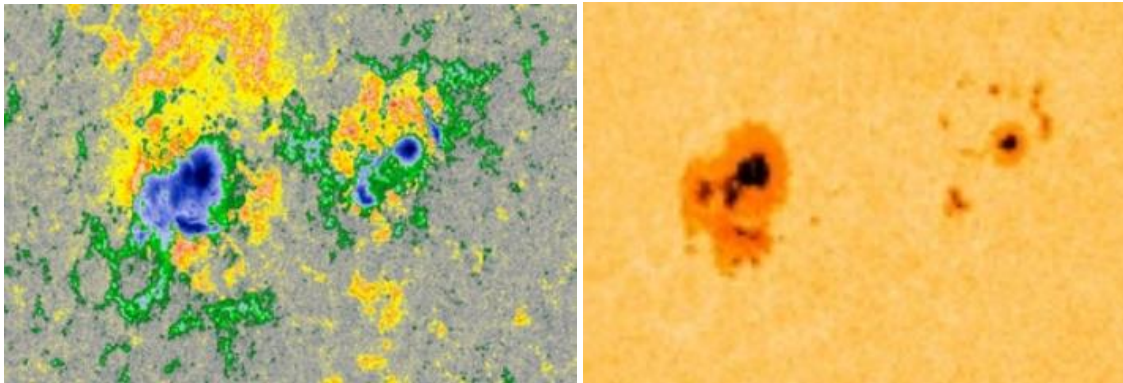


Figure 3: Latest Intensitygram and Magnetogram imagery of the AR3435/AR3448 region showing increased magnetic complexity of both regions.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at Background levels, but with a daily slight chance of flux levels rising in response to any significant flaring, or perhaps early in the period in association with continued CME impacts.

Radiation Storms	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	10	5	5	5
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy (greater than 2MeV) electron flux levels are currently close to the High threshold around 1000pfu. An uncertain forecast, with CME arrivals and continued elevated solar winds likely to have seen a build up of change within the belts and any easing of solar winds and reduction of geomagnetic activity expected to see flux levels increasingly rise above the High threshold. Some reduction likely in the near term however, both diurnally but also given the potential for further geomagnetic activity.

The 24-hour fluence is currently below the Active threshold but on a rising trend, with current MOSWOC REFM model output forecast providing reasonable guidance, with a much increased, and now likely, risk of breaching the active threshold later Day 1 (20 Sep). Forecast remains lower confidence however given uncertainties in the near term.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	60	70	80	80
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	5	5

Figure 4: Latest MOSWOC REFM model output, showing recent Fluence increase. Forecast output preferred to Recurrence.

